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EXAMINER	
LAROSE, COLIN M	

ART UNIT	PAPER NUMBER
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/846,718	CHEN ET AL.	
	Examiner	Art Unit	
	Colin M. LaRose	2627	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 November 2005*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-36* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *7,9-14,25,26,30,31,35 and 36* is/are allowed.

6)☒ Claim(s) *1-6,8,15-24,27-29 and 32-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Arguments and Amendments

1. Applicant's amendments and arguments filed 16 November 2005, have been entered and made of record.

Response to Amendments and Arguments

2. Previously objected claims 25 and 35 have been rewritten in independent form and are therefore allowable. Claim 26, which depends from claim 25, is also allowable.

3. Regarding claims 1 and 27, Applicant argues that Hong (6,633,655) does not disclose detecting iris colored pixels. Applicant argues that Hong tracks pupils rather than irides. See Applicant's Remarks, p. 13.

In response, Examiner maintains that the previous interpretation was proper. A "pupil" is defined as "the contractile aperture in the iris of the eye" (Merriam-Webster's Collegiate Dictionary, 10th ed., 2001). Since the pupil is a component of the iris, it is not unreasonable to interpret detecting pupil colored pixels as being substantially synonymous to detecting iris colored pixels. As shown by Hong, pupils have a distinct color that is utilized for detection and tracking purposes. Absent further claim language that clearly denotes that the pupil region is not detected – e.g. "iris color pixels excluding pupil colored pixels" – the previous interpretation of "iris colored pixels" encompassing either the pupil or non-pupil region, or both, of the iris, is maintained.

Also, Applicant states that, "[s]ince the pupil is geometrically enclosed within the iris, finding the pupil region does not identify the boundary of the iris region," and therefore, "Hong's tracking of the eye pupils is not equivalent to the present invention's claimed feature of detecting iris colored pixels" (p. 13 of Remarks). While it may be true that tracking the pupil region is not the same as tracking the boundary of the entire iris, such a feature is not claimed. The claims merely call for "detecting a plurality of iris colored pixels," and no mention is made of the boundary of the iris.

Applicant also asserts that Hong does not group detected pixels into clusters, as claimed, However, Hong does appear to group the iris colored pixels into clusters – column 6, lines 16-35: Hong assigns either a 1 or 0 to colored pixels within the pupil region of the iris, and then analyzes clusters of "1" pixels to detect a centroid of the region.

Applicant also presents the argument that Hong is directed to tracking known faces rather than unknown faces as in the present invention. However, this line of argument does not appear to be relevant, as the claim does not preclude the location of the face from being known in advance. Furthermore, Hong's disclosure is directed to tracking an observer's eyes, which includes detecting the location of the eyes. In addition, Hong's face appears to be initially unknown, and Hong performs steps to detect a face region – see column 5, lines 19-30. The passages cited by the Applicant (col. 11, lines 41-44 and col. 12, lines 8-11) merely state that the size of the face is known, not the location. Therefore, Hong's eye positions are initially unknown.

Regarding claims 2 and 28, Applicant argues that Kim "does not teach a method of selectively applying histogram equalization to particular images" (p. 15 of Remarks). Such a limitation of "selectively" applying histogram equalization to particular images is not found in the claims and appears to be irrelevant.

Regarding claims 3 and 4, Applicant argues that "Hong does not provide an intensity probability distribution of pupil and a probability distribution of non-pupil," however, the claims do not require as such. The claims only require a "probability analysis" by applying a Bayesian model. Woods & Gonzalez was relied upon for the teaching that classifying pixels using Bayesian probability analysis was well-known and would have been an obvious modification.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1, 16-18, 21, 23, 24, 27, 29, and 33 are rejected under 35 U.S.C. 102(e) as being anticipated by Hong et al. (U.S. Patent 6,633,655).

The following is in regard to Claim 1. Hong discloses a method for detecting a human face and tracking an observer. This method involves the detection and location of various facial features, including a pair of eyes and a mouth. Hong et al.'s method comprises the steps of:

a. Detecting a plurality of iris colored pixels in the digital face image (e.g. column 6, lines 33-35 of Hong et al.).

b. Grouping the plurality of iris colored pixels into iris color pixel clusters[1] (e.g. *eye pupil regions* – column 6, lines 16-35 of Hong et al.), each iris color pixel being representative of a candidate eye position.

c. Selecting a pair of candidate eye positions (e.g. centroids – column 6, lines 33-35 of Hong et al.).

d. Identifying salient pixels image (e.g. pixels constituting *uniform blobs* – step S23 of Hong et al. Fig. 23 and column 11, lines 49-50) relating to a facial feature in the digital face. Pixels forming the uniform blobs later are used to define regions corresponding to the subjects face and facial features. These are prominent (have uniform saturation corresponding to the properties of human skin – Hong et al. column 11, lines 25-26) with respect to the rest of the image, and can, therefore, be regarded as *salient.*

e. Generating a signature curve (i.e. vertical and/or horizontal integral projections – e.g. $V(x)$ in Hong et al. column 15) using the salient pixels. See Fig. 16 and column 19, lines 34-53 of Hong et al.

f. Using the signature curve and the eye positions to locate a mouth position. See column 19, lines 34-53 of Hong et al.

It has thus been shown that Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 1. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 1.

The following is in regard to Claim 16. As shown above, Hong et al. teach a method that is in accordance with claim 1. In addition, the method Hong et al. generates a signature curve by projecting the salient pixels onto a vertical axis (e.g. the horizontal integral projections $H_L(y)$ and $H_R(y)$). See Hong et al. column 17, lines 4-20 and Fig. 20B. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 16.

The following is in regard to Claim 17. As shown above, Hong et al. teach a method that is in accordance with claim 1. In addition, the method Hong et al. finds the peaks of the vertical (and horizontal) integral projections

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1 Note that in this document Hong et al.'s eye pupil regions or eye regions (Hong et al. Abstract or Fig. 21) will be interpreted as being analogous to the Applicant's claimed iris pixel clusters. Therefore, for the remaining portions of this document these terms will be referred to interchangeably with iris pixel clusters.

(e.g. the signature curve(s)). See, for example, step S42 of Fig. 18 of Hong et al. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 17.

The following is in regard to Claim 18. As shown above, Hong et al. teach a method that is in accordance with claim 17. The step of finding peaks of the signature curve (corresponding to the mouth – Hong et al. Fig. 24), in the method of Hong et al., further includes:

(18.a.) Separating the digital face image into an upper half region (e.g. upper rectangular region illustrated in Fig. 24 of Hong et al.) and a lower half region (e.g. rectangle A′B′C′D′ illustrated in Fig. 24 of Hong et al.). Designating these regions as *upper half* and *lower half*, respectively, is arbitrary.

(18.b.) Finding the peak of the signature curve disposed within the lower half region. Again, referring to Fig. 24 of Hong et al., the peak of the signature curve is Y_P or X_P, depending which of the curves depicted is chosen as the signature curve.

In this way, the teachings of Hong et al. anticipate all limitations of claim 18.

The following is in regard to Claim 21. As shown above, Hong et al. teach a method that is in accordance with claim 1. The step of using the signature curve and the eye positions, in the method of Hong et al. (see claim 1, step (f) above), to locate a mouth position comprises the steps of:

(21.a.) Determining a horizontal coordinate (i.e. X_1, X_P, and X_2) of the mouth. See Fig. 24 of Hong et al.

(21.b.) Using a bottom peak position (i.e. Y_P) on the signature curve as a vertical coordinate of the mouth. See Fig. 24 of Hong et al.

It has thus been shown that the teachings of Hong et al. address all limitations of claim 21. Therefore, Hong et al. anticipates the method of claim 21.

The following is in regard to Claim 23. As shown above, Hong et al. teach a method that is in accordance with claim 1. The method of Hong et al. further comprises the step of validating the eyes (e.g. eye symmetry with respect to a center line – Hong et al. column 16, lines 10-23) and mouth position (e.g. Hong et al. column 20, lines 5-15). It has thus been shown that the teachings of Hong et al. address all limitations of claim 23. Therefore, Hong et al. anticipates the method of claim 23.

The following is in regard to Claim 24. As shown above, Hong et al. teach a method that is in accordance with claim 23. The step of validating the eyes and mouth position comprises the steps of obtaining statistics relating to relative positions of eyes and mouth and validating the eyes and mouth position using the statistics. See Hong et al. column 20, lines 5-15. It has thus been shown that the teachings of Hong et al. address all limitations of claim 24. Therefore, Hong et al. anticipates the method of claim 24.

The following is in regard to Claim 27. It was shown in the preceding discussion, relating to claim 1, that the teachings of Hong et al. address items (a)-(e) and (g) of claim 27 (where items (a)-(e) of claim 1 correspond to items (a)-(e) of claim 27 and item (f) of claim 1 corresponds to item (g) of claim 27). In addition to these steps (a)-(f), the method of Hong et al. further comprises the steps:

f. Finding the peaks of the signature curve. See, for example, Hong et al. column 19, lines 41-45.

h. Validating the eyes and mouth position. See, for example, Hong et al. column 6, lines 65-67 to column 7, lines 1-2.

Taking into account the previous discussion relating to claim 27, it has thus been shown that Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Therefore, the teachings of Hong et al. anticipate the digital image processing method claimed in Applicant's claim 27.

The following is in regard to Claims 29 and 33. As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27., respectively, these claims limits claim 27 in essentially the same manner as claims 5 and 16, respectively. Therefore, with regard to claims 29 and 33, remarks analogous to those presented above, with respect to claim 5 and 16, are respectively applicable.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. Claims 2 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Kim (U.S. Patent 6,049,626).

The following is in regard to Claim 2. As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 1. In the method of Hong et al., the step of detecting a plurality of iris colored pixels in the digital face image, further includes:

b. Identifying a plurality of skin color regions. See, for example, Hong et al. column 11 lines 22-50, column 18 lines 40-45, column 19, 25-34 and S23 of Fig. 7.

c. Identifying a face region from the plurality of skin color regions. See, for example, Hong et al. column 11, lines 49-55 and Fig. 7, steps S23-S25.

d. Examining pixels in the face region to detect the plurality of iris colored pixels. See, for example, Hong et al. column 6, lines 20-30.

Hong et al. do not, however, show or suggest that this step of detecting a plurality of iris colored pixels additionally include:

a. Performing a color histogram equalization of the digital face image based on a color mean statistical analysis of the digital face image.

Kim discloses a technique for equalizing a color image using color mean analysis. In particular, Kim discloses utilizing histogram equalization in order to enhance the appearance of an image based on a color mean analysis thereof. The image is analyzed in order to divide it into regions according to mean luminance, which is a combination of the three tristimulus colors. Then, the image is subject to histogram equalization based on the color mean analysis. See figure 6.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Hong by Kim to pre-process the face image by histogram equalization based on a color mean analysis, as claimed, since

Kim teaches that such a process is advantageous for enhancing the quality of a color image so that the image is more pleasing and exhibits improved contrast and the like. See column 2, lines 10-24.

The following is in regard to Claim 28. As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that while the subject matter claimed in claim 28 is different than that which is claimed in claim 2 (due to its dependence on claim 27), claim 28 limits its parent claim (i.e. claim 27) in exactly the same manner. Therefore, with regard to claim 28, remarks analogous to those presented above with respect to claim 2, are applicable.

8. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al. and Kim, as applied above, in further view of Gonzalez and Woods ("Digital Image Processing", Section 9.3.2: Optimum Statistical Classifiers, pp. 586-595).

The following is in regard to Claim 3. As shown above, the teachings of Hong et al. and Kim can be combined to satisfy all the limitations of claim 2. Furthermore, in the aforementioned method of Hong et al., the step of examining pixels in the face region to detect the plurality of iris colored pixels includes: (a) measuring a red intensity of the pixel. This is suggested, for example, in step S10 of Fig. 14 of Hong et al. However, neither Hong et al. nor Kim show or suggest applying a probability analysis to classify the pixel as iris colored.

Bayesian classification or Bayesian clustering is a well-known and often-used probabilistic means to cluster, partition, and/or classify image data (and a myriad of other types of data) according to a specified set of features (or, using the nomenclature of Gonzalez and Woods, *unknown patterns*). See, for example, the last paragraph on page 586 of Gonzales and Woods. Gonzalez and Woods illustrate a specific application of Bayesian classification to digital image data in the example given on pages 592-595.

The teachings of Hong et al. and Kim, combined in the manner discussed above, are compatible with the teachings of Gonzalez and Woods because each is directed and/or applicable to the processing of digital image data. Therefore, having prior knowledge of the color properties of irises (or pupil region), it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use Bayesian classification to assign each pixel of the digital image to a class (cluster) ω_i, among a plurality of classes $\{\omega_k \mid k = 1 \dots M\}$ (clusters)

according to their color (i.e. unknown pattern x – see pages 586-587 of Gonzalez and Woods), where one class corresponds to the known color properties of the iris (or pupil region), thereby detecting the plurality of iris colored pixels (e.g. eye pupil regions – column 6, lines 33-35 of Hong et al.). The motivation/suggestion to use Bayesian classification to classify pixels in this manner is that Bayesian Classifiers provide optimal classification (paragraph 1 of Section 9.3.2 on page 586 of Gonzales and Woods). By incorporating Bayesian classification into the method, obtained by combining the teachings of Hong et al. and Kim, in the manner described above, one would obtain a method that satisfies the limitations of claim 3.

The following is in regard to Claim 4. As shown above, the teachings of Hong et al., Kim and Gonzales and Woods can be combined to satisfy all the limitations of claim 3. Bayesian classifiers are based on Bayes' rule. See equations (9.3-9) to (9.3-12) and paragraphs 2-4 on pages 586-587 of Gonzalez and Woods. Clearly, the subject matter claimed in claim 4 is addressed by the discussion above. Therefore, the method derived from combining Bayesian classification, in the manner proposed above, with the aforementioned combination of Hong et al. and Kim, is such that the step of applying a probability analysis comprises the step of applying a Bayesian model. This combination thus satisfies the limitations of claim 4.

9. Claims 5, 6, and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Chen et al. (U.S. Patent Application Publication 2002/0136450).

The following is in regard to Claim 5. As shown above, Hong et al. teach a method that is in accordance with claim 1. The method taught by Hong et al. further comprises the step of validating the iris pixel clusters (e.g. measuring its horizontal symmetry with respect to a center line – see Hong et al. Fig. 16, column 15 lines 12-15 and column 16, lines 10-23; or measuring the separation of iris (eyes) – see Hong et al. column 15, lines 59-67).

However, Hong does not appear to disclose the validating includes determining if the cluster should be removed from consideration.

Chen discloses a method of processing eyes in a digital image and involves detecting eyes regions. In particular, Chen discloses detecting eye candidate regions and then using a validation process to remove candidate regions that are not indicative of the actual location of the eyes. See Paragraphs 27-32, wherein Chen employs five rules that are utilized for eliminating candidate regions that do not conform to eye characteristics.

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify Hong by Chen by validating the iris pixel clusters to determine if any clusters should be removed from consideration, since Chen teaches that, when detecting the locations of the eyes in a digital image of a face, it is both conventional and advantageous to examine the eye candidate regions, or clusters, to determine whether some of the regions are not indicative of eyes and to eliminate those that are not indicative of being the actual location of the eyes. Such a process of validation by elimination facilitates the process of determining the location of the eyes.

The following is in regard to Claim 6. As shown above, Chen et al. teaches a method that satisfies the limitations of claim 5. While Hong et al. do show the measurement of the vertical and horizontal dimensions of eye regions, their method does not include a step of validating the iris pixel clusters comprising the steps of:

(6.a.) Determining the height to width ratio of each iris pixel cluster; and

(6.b.) Invalidating the iris pixel cluster if the height to width ratio is greater than a pre-determined value.

Chen et al., on the other hand, disclose a method for the detection of an eye (red-eye) that includes a "validation" step, comprising the steps of:

(6.a′.) Determining the height to width ratio (i.e. aspect ratio) of each iris pixel cluster (i.e. pixel groups representative of candidate red-eye regions – Chen et al. column 3, paragraph [0026]). See paragraph [0031] in column 3 of Chen et al.

(6.b′.) Invalidating the iris pixel cluster if the height to width ratio is greater than a pre-determined value (e.g. upper bound 2.0). See paragraph [0031] in column 3 of Chen et al.

Hong et al. and Chen et al. are combinable because they are analogous art. In particular, both attempt to solve the problem of identifying and locating regions of the image corresponding to the eyes of individual depicted in a digital image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to validate pixel clusters according to steps (6.a′.) and (6.b′.) above, in lieu of, or in addition to the validation step proposed by Hong et al. and discussed above, relative to claim 5. The motivation/suggestion to do so would have been to provide a straightforward method in which to eliminate pixel clusters that do not correspond to the known spatial dimensions of the human eye. Combining the teachings of Hong

et al. and Chen et al., in this manner, yields a digital image processing method that conforms to that which is claimed in claim 6.

The following is in regard to Claim 8. As shown above, Hong et al. teaches a method that satisfies the limitations of claim 1. However, the aforementioned step of grouping the plurality of iris colored pixels into clusters, as taught by Hong et al., does not comprise the step of determining whether each iris colored pixel is within a predetermined distance to another pixel in the iris pixel cluster.

The method of eye detection taught by Chen et al., discussed above, includes a *pixel grouper* (Chen et al. Fig. 2, reference number 132) that groups candidate pixels into the same group if their distance is no more than one, or, alternatively, if they are separated by some predetermined threshold distance. See Chen et al. column 2, paragraph [0025]. In other words, grouping according to Chen et al.'s method comprises the step of determining whether each iris colored pixel is within a predetermined distance to another pixel in the iris pixel cluster.

Hong et al. and Chen et al. are combinable because they are analogous art. In particular, both attempt to solve the problem of identifying and locating regions of the image corresponding to the eyes of individual depicted in a digital image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to group candidate eye or iris pixels according to the teachings of Chen et al., in lieu of, or in addition to, the pixel grouping of Hong et al.'s method. The motivation/suggestion for doing so would have been to provide a simple method for *spatial* clustering of pixels. This, in turn, coarsely defines certain geometric structures in the image that may represent the known geometric structure of the human eye. Combining the teachings of Hong et al. and Chen et al., in this manner, yields a digital image processing method that is in accordance with that which is claimed in claim 8.

10. Claims 15 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Luo (U.S. Patent 6,151,403), in further view of Gonzales and Woods ("Digital Image Processing", Section 4.3.3, pages 196-197.

The following is in regard to Claim 15. As shown above, Hong et al. teaches a method that satisfies the limitations of claim 1. While Hong et al. teaches the step of identifying salient pixels, Hong et al. does not expressly disclose that such a step should comprise the steps of:

(15.a.) Morphologically smoothing the digital face image to generate a smoothed face image,

(15.b.) High-boost filtering the smoothed face image to generate a filtered face image, and

(15.c) Thresholding the filtered face image into a binary image having salient pixels

Luo discloses a method for detecting human eyes in a digital image that includes a step of identifying salient pixels within a *sub-image* of the face by morphologically smoothing the sub-image of the face (Luo Fig. 5 step S10a), deriving a valley or map (Luo Fig. 5 step S10b) and thresholding that image (Luo column 5, lines 23-25) to form a binarized map (Luo Fig. 5 step S10h) indicating the presence of salient features within the sub-image. See column 4, lines 45-67 to column 5, lines 1-25. It would be clear to one of ordinary skill in the art that the sub-image can be defined so as to encompass the entire face image (or, using Luo's nomenclature, the flesh region) without defeating the purpose of the said step of identifying salient pixels within a *sub-image*[2].

Hong et al. and Luo are combinable because they are analogous art. That is, both attempt to solve the problem of identifying and locating salient regions of the image corresponding to the face and, more particularly eyes the of individual depicted in a digital image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to modify the method of Hong et al. so as to identify salient pixels in the input digital image in the manner proposed by Luo. The motivation/suggestion for doing so would have been to advantageously remove noise and illumination defects (via morphological smoothing – see Luo column 5, lines 2-6), flat flesh regions (via valley detection – see Luo column 4, lines 67) of the input image, and provide a binary mask for readily identifying candidate regions of the image corresponding to the eye (or other facial features).

Note that in order to remove flat features in the facial image (flesh region), Luo resorts to constructing a valley map. However, neither Hong et al. nor Luo show or suggest high-boost filtering the smoothed face image to generate a filtered face image.

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2 This would simply increase the scope of the search for eye locations.

High-boost filtering is a well-known method of removing low-frequency regions (e.g. flat regions) of an image, thereby providing a rudimentary means to emphasize edges or other high-frequency regions of the image. It would be understood by one of ordinary skill in the art that such high-frequency regions contained in a digital image of a face would include prominent facial features such as the eyes and mouth. Gonzales and Woods show the application of high-boost filtering to digital images on pages 196-198. Note, in particular, the emphasis of high-frequency regions of an image and the suppression of low-frequency regions illustrated in Fig. 4.27 on page 198 of Gonzalez and Woods.

The teachings of Hong et al. and Luo, combined in the manner described above, are compatible with those of Gonzalez and Woods, relating to high-boost filtering because these teachings are analogous art. Each of these teachings is directed to the processing of digital images. In particular, the high-boost filtering taught by Gonzalez and Woods provides an alternate means to that which is proposed by Luo, of detecting and removing flat flesh regions of the facial image. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use high-pass filtering as opposed to the valley detection of Luo, in the method derived from the combination of Hong et al. and Luo. The motivation/suggestion for doing so is that high-boost filtering, as taught by Gonzalez and Woods, provides more flexibility, with the parameter A (see equation 4.3.3 on page 196 of Gonzalez and Woods), to emphasize high-frequency regions and suppress low-frequency regions of the facial image. Combining the teachings of Hong et al., Luo, and Gonzalez and Woods yields a method that satisfies the limitations of claim 15.

The following is in regard to Claim 32. As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that the limitations of claim 32 are essentially the same as those set forth in claim 15. Therefore, with regard to claim 32, remarks analogous to those presented above with respect to claim 15, are applicable.

11. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Funayama et al. (U.S. Patent Application Publication 2001/0014182).

The following is in regard to Claim 19. As shown above, Hong et al. teach a method that is in accordance with claim 18. Hong et al. do not, however, teach that the step of separating the digital face image into the upper half region and the lower half region comprises the steps of:

(19.a.) Determining a top boundary of the digital face image,

(19.b.) Determining a bottom boundary of the digital face image, and

(19.c) Determining a mid-point between the top boundary and the bottom boundary.

Funayama et al., on the other hand, discloses a digital image processing apparatus that includes the identification and location of various facial features (e.g. mouth and eyes) by inspection of horizontal and vertical histogram (integral) projections (e.g. Funayama et al. Figs. 22-26). This apparatus performs the following steps:

(19.a.) Determining a top boundary of the digital face image. This step is inherent to Funayama et al.'s determination of the *face-skin region* (Funayama et al. Fig. 10, reference number 10-2) within the input digital image and the determination of the *face mask* (Funayama et al. Fig. 19, reference number 17-6), which indicates the boundary of the face.

(19.b.) Determining a bottom boundary of the digital face image. This step is inherent to Funayama et al.'s determination of the *face-skin region* (Funayama et al. Fig. 10, reference number 10-2) within the input digital image and the determination of the *face mask* (Funayama et al. Fig. 19, reference number 17-6), which indicates the boundary of the face.

(19.c) Determining a mid-point (Funayama et al. Fig. 27, reference number 26-7) between the top boundary and the bottom boundary. See, for example, Funayama et al. column 3 paragraph [0035] and column 9 paragraphs [0127], [0130], and [0132].

Hong et al. and Funayama et al. are combinable because they are analogous art. That is, both authors disclose methods of digital image processing involving the detection and location of various human facial features via histogram projections. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to augment the step of separating the digital face image into the upper half region and the lower half region, as taught by Hong et al., with steps (19.a)-(19.c), as taught by Funayama et al. The motivation/suggestion for doing so would have been to restrict the search of the various facial features to the area of

the image between the top and bottom boundaries of the face and to further define the search space of specific facial features that would be local to the top and bottom regions of the face, delineated by the determined mid-point (e.g. eyes are searched for in the top region and the mouth search for in the bottom). This advantageously improves search accuracy and speed. Combining the teachings of Hong et al. and Funayama et al. in the manner proposed above would yield a digital image processing method that is in accordance with claim 19.

12. Claims 20, 22, and 34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hong et al., in view of Luo (U.S. Patent 6,151,403).

The following is in regard to Claim 20. As shown above, Hong et al. teaches a method that satisfies the limitations of claim 17. The step of finding peaks of the signature curve, in the method of Hong et al., further includes:

(20.a.) Separating the digital face image into an upper half region and a lower half region.

(20.c.) Finding the peak of the signature curve disposed within the lower half region.

See the discussion above with regard to claim 18 (steps (18.a) and (18.b)). Hong et al., however, does not show or suggest that step of finding peaks of the signature curve involve: (20.b) smoothing the signature curve.

34. Luo discloses a method for detecting human eyes in a digital image that includes the smoothing of a signature curve – in this case a histogram – prior to finding its peaks. See Luo Fig. 3 steps S4d-S4f. Note that an integral projection, such as that which is used by Hong et al., is a histogram.

35. Hong et al. and Luo are combinable because they are analogous art. Specifically, the teachings of Hong et al. and Luo are directed to the detection and location of facial features within an image depicting a human face. Furthermore, though the histograms of Luo and Hong et al. differ in their specific purpose and mathematical representation, the teachings of Luo relating histogram smoothing, and the purpose it may serve in facial feature detection, are still applicable to the method of Hong et al. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to smooth the signature curve of Hong et al.'s method (e.g. vertical or horizontal integral projections) prior to finding its peaks, as taught by Luo. The motivation/suggestion for doing so would have been that smoothing the histogram reduces noise, thereby

eliminating spurious peaks that may otherwise have been falsely (or wastefully) detected. Combining the teachings of Hong et al. and Luo, in this manner, would provide a digital image processing method that conforms to the limitations of claim 20.

The following is in regard to Claim 22. As shown above, Hong et al. teaches a method that satisfies the limitations of claim 1. The step of using the signature curve and the eye positions to locate a mouth position, in the method of Hong et al., further includes the steps of:

(22.a.) Locating a position midway between the eye positions. This is suggested in Hong et al. column 17, lines 48-51.

(22.c.) Locating a bottom peak position (i.e. Y_P – Hong et al. Fig. 24) on the signature curve.

(22.d.) Defining the bottom peak position as a vertical coordinate of the mouth. See Hong et al. Fig. 24.

Though it is clear from Fig. 24 that the peak X_P of the vertical projection is a horizontal coordinate of the mouth in nearly the same location of the midway position between the two detected eyes, Hong et al. does indicate that these positions are or should be the same. In other words, Hong et al. does not show or suggest: (22.b) Defining the midway position as a horizontal coordinate of the mouth.

36. In the method of Luo, on the other hand, the midway position between the eye positions is used as a horizontal coordinate of the mouth. See Fig. 10 of Luo.

Hong et al. and Luo are combinable because they are analogous art. Specifically, the teachings of Hong et al. and Luo are directed to the detection and location of facial features (including a mouth) within an image depicting a human face. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use, in the manner of Luo, the midway position between the eye positions as a horizontal coordinate of the mouth, as opposed, or in addition to, the peak X_P of the vertical projection, in the method of Hong et al. The motivation/suggestion for doing so would have been that defining a horizontal coordinate using the midway position between the already derived eye positions is clearly easier than defining it as the peak X_P of the vertical integral projection. By combining the teachings of Hong et al. and Luo in this manner, one obtains a digital image processing method that conforms to the limitations of claim 22.

The following is in regard to Claim 34. As shown above, Hong et al.'s method of human face detection and tracking is digital image processing method that conforms to all aspects of the method claimed in Applicant's claim 27. Note that the limitations of claim 34 are essentially the same as those set forth in claim 22. Therefore, with regard to claim 34, remarks analogous to those presented above with respect to claim 22, are applicable.

Allowable Subject Matter

13. Claims 7, 9-14, 25, 26, 30, 31, 35, and 36 are allowed.

Conclusion

14. This is a continuation of applicant's earlier application having the same serial number. All claims are drawn to the same invention claimed in the earlier application and could have been finally rejected on the grounds and art of record in the next Office action if they had been entered in the earlier application. Accordingly, **THIS ACTION IS MADE FINAL** even though it is a first action in this case. See MPEP § 706.07(b). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no, however, event will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Colin M. LaRose whose telephone number is (571) 272-7423. If attempts to reach the examiner by telephone are unsuccessful, the examiner's acting supervisor, Bhavesh Mehta, can be reached on (571) 272-7453. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the TC 2600 Customer Service Office whose telephone number is (571) 272-2600.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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PRIMARY EXAMINER